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Washington, D.C. 20554

**Federal Communications Commission  
Office of Secretary**

WT Docket No. 98-136

**To: The Commission**

**COMMENTS OF  
ANGEL TECHNOLOGIES CORPORATION**

**ANGEL TECHNOLOGIES CORPORATION**

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## **SUMMARY**

In these comments, Angel responds to the Notice of Proposed Rulemaking ("NPRM") issued by the Commission on July 29, 1998. Specifically, the Commission proposes to permit the operation of all services in the 47 GHz band permitted in the United States Table of Allocations including Fixed, Mobile and Fixed Satellite services. The Commission notes that the 47 GHz bands may be used by High Altitude Platform Stations ("HAPS"), and proposes application, licensing and processing rules to facilitate the prompt licensing of 47 GHz systems. Additionally, the Commission seeks comments on rules concerning in-band interference control, out-of-band and spurious emission limits and RF exposure safety requirements. It also seeks comment on questions relating to the operation of stratospheric platforms in the bands. As discussed in these comments, Angel supports the proposed rules and believes that the 47 GHz band is ideal for use by High Altitude Long Operation ("HALO") platforms being developed by Angel.

Angel Technologies Corporation was formed in 1995 to develop and implement wireless communications networks using HALO aircraft. Angel, through the use of HALOs, will be able to provide fixed and mobile wireless communication services to users throughout the United States and the world. From an individual HALO aircraft, Angel will offer ubiquitous access and dedicated point-to-point and point-to-multipoint connections throughout a "footprint" 50 to 75 miles in diameter for millimeter wave carrier bands. The HALO-based system provides a simple and low-cost option for putting in place a wireless communications infrastructure using the 47 GHz band.

Angel believes that the service and operational rules proposed by the Commission in the NPRM can facilitate this goal. Specifically, Angel supports the Commission's proposal to allow operation of all services in the 47 GHz band permitted in the United States Table of Allocations. The flexibility inherent in these policies will let the marketplace determine which technologies and

services can most efficiently be provided. From Angel's perspective, this flexible approach should facilitate the implementation of HALO platforms.

Angel supports the proposed technical rules except for the following proposed changes. First, Angel encourages the Commission to increase its proposed 16 dBW EIRP power limit for 47 GHz stations to 44 dBW. Second, Angel encourages the use of an elevation angle discriminator as the best method for coordinating stratospheric systems with terrestrial systems. Such an approach could significantly simplify coordination between stratospheric platforms and terrestrial services operating in the same band, in the same territory.

Third, Angel urges the Commission to adopt in § 27.4 of the Rules: the following definition of HAPS.

A station located on an object at an altitude of 15-50 km and at a specified fixed point relative to the Earth.

This definition will enable multiple HAPS technologies, including HALOs, to flourish in the 47 GHz band. To adopt the HAPS definition proposed by the Commission would merely result in discouraging use of certain technological approaches based on an arbitrary height limitation. This would be at odds with the philosophical underpinning of the NPRM to promote the use of a wide variety of technologies and services in the 47 GHz band.

Fourth, Angel believes that terrestrial and stratospheric systems can share the same spectrum if an angle discriminator is used. Specifically, if a minimum 20 degree elevation angle is used for stratospheric systems and a maximum of 10 degrees is used for terrestrial systems, it is possible to obtain a minimum of 50 dB of isolation between these two technological approaches. Thus, Angel

disagrees with the Sky Station position that co-channel frequency sharing of stratospheric platform systems and traditional fixed services is not possible in the same geographic area.

With the adoption of the changes suggested herein by Angel, the Rules proposed by the Commission for the 47 GHz band will allow the rapid introduction of new technologies and services in the 47 GHz band.

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Amendment of Part 27 of the  
Commission's Rules to Revise Rules  
for Services in the 2.3 GHz Band  
and to Include Licensing of Services  
In the 47 GHz Band

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WT Docket No. 98-136

To: The Commission

**COMMENTS OF**  
**ANGEL TECHNOLOGIES CORPORATION**

Angel Technologies Corporation ("Angel"), by counsel, hereby submits its comments in the above-captioned proceeding. Angel is a developer of wireless communications networks using high altitude long operation ("HALO™") aircraft. In these comments, Angel supports the Commission's proposals in WT Docket No. 98-136. Specifically with the few changes suggested herein, Angel urges the Commission to expeditiously adopt its proposed licensing and operating rules for the 47.2-47.5 GHz and 47.9-48.2 GHz frequency bands ("47 GHz band"). These rules will facilitate the expeditious introduction of new telecommunication services using the 47 GHz band including telecommunication services provided from HALO aircraft.

**I. BACKGROUND**

In these comments, Angel responds to the Notice of Proposed Rulemaking ("NPRM") issued by the Commission on July 29, 1998.<sup>1/</sup> Specifically, the Commission proposes to permit the

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<sup>1/</sup> See Amendment to Part 27 of the Commission's Rules to Revise Rules for Services in the 2.3 GHz band to include Licensing of Services in the 47 GHz band, WT Docket No. 98-136, FCC 98-142, released July 19, 1998 ("NPRM").

operation of all services in the 47 GHz band permitted in the United States Table of Allocations including Fixed, Mobile and Fixed Satellite services. The Commission notes that the 47 GHz bands may be used by High Altitude Platform Stations ("HAPS"), and proposes application, licensing and processing rules to facilitate the prompt licensing of 47 GHz systems. Additionally, the Commission seeks comments on rules concerning in-band interference control, out-of-band and spurious emission limits and RF exposure safety requirements. It also seeks comments on questions relating to the operation of stratospheric platforms in the bands. As discussed below, Angel supports the proposed rules and believes that the 47 GHz band is ideal for use by HALO platforms.

**II. ANGEL'S HALO TECHNOLOGY WILL BE AN EFFICIENT AND UBIQUITOUS MEANS TO PROVIDE TELECOMMUNICATION SERVICES USING THE 47 GHz FREQUENCY BAND ACROSS AN ENTIRE METROPOLITAN AREA.**

Angel Technologies Corporation was formed in 1995 to develop and implement wireless communications networks using HALO aircraft. Angel, through the use of HALOs, will be able to provide fixed and mobile wireless communication services to users throughout the United States and the world. The Angel HALO aircraft, also known as Proteus, was designed by Burt Rutan (designer of the Voyager Aircraft, which in 1986 flew around the world without refueling) and his team at Scaled Composites Inc.<sup>2/</sup> The Proteus commenced flight testing in July 1998. The airplane by virtue of its significant payload carrying capabilities and its operational characteristics will be able to provide a variety of communication services including IMT-2000, LMDS, 38 GHz and 47 GHz

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<sup>2/</sup> Scaled Composites Inc. is the world's premier aircraft design and prototyping enterprise.

services.<sup>3/</sup> From an individual HALO aircraft, Angel will offer ubiquitous access and dedicated point-to-point and point-to-multipoint connections throughout a "footprint" 50 to 75 miles in diameter for millimeter wave carrier bands. The HALO-based system provides a simple and low-cost option for putting in place a wireless communications infrastructure. The HALO, which is a piloted FAA-certified aircraft, will serve as the airborne "hub" of the network. In order to maintain a stable coverage area, the HALO will continuously fly orbits of five to eight nautical miles at 50,000 to 60,000 feet above large metropolitan areas. A single airborne hub can thus provide service to approximately 4400 square miles. A HALO network can be put in place using only three planes with two pilots each. By trading off eight hour shifts, Angel will be able to provide continuous 24-hour per day service.

A HALO network is an efficient means to deploy a wide-area fixed or mobile communications network, such as is being considered for implementation in the 47 GHz band. A number of attributes of HALOs offer the following specific benefits for 47 GHz service:

- *Ubiquity.* Perhaps the most compelling attribute of the HALO Network is the ubiquitous nature of its services within the signal footprint. Once the HALO is flying overhead - on Day 1 of service - anyone within the footprint can access service and communicate with anyone else within that footprint.
- *Immediate Equal Access.* Deployment does not favor certain locations more than others. Advanced mobile services can be made available with one airborne hub.

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<sup>3/</sup> See Appendix A for a more detailed description of the Angel HALO aircraft and network and the Angel brochure.



- *Rapid Introduction of Competition.* Angel's HALO deployment hastens competition both for IMT-2000 as well as other advanced broadband services.
- *Upgradeability.* The total capacity of the HALO Network can be increased by swapping out the "Hub" or the communications payload with an upgraded version.
- *Highest Network Reliability/Maintenance.* After each landing of the HALO aircraft, the network operations team will be able to conduct a complete and thorough "check-out" of the entire network, thus making sure that the network is operating at an optimal level of performance at the beginning of each shift.
- *Disaster-Resistant Infrastructure.* By virtue of the airborne nature of the HALO Network, Angel is able to offer a system that is disaster-resistant to earthquakes, tornadoes, and hurricanes.<sup>4/</sup>

Given the above attributes, Angel believes that HALOs have many attributes that will enhance the utility of the 47 GHz frequency band.

### **III. ANGEL SUPPORTS THE FLEXIBLE SERVICE RULES PROPOSED BY THE COMMISSION IN THE NPRM.**

Angel's principal interest in this proceeding is that the Commission develop a regulatory framework for the 47 GHz band that will allow a variety of technologies and services to flourish. Its particular concern is to insure that there are no regulatory impediments to the use of HALO platforms as a means to provide 47 GHz services. Angel believes that the service and operational rules proposed by the Commission in the NPRM can facilitate this goal. Specifically, Angel

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<sup>4/</sup>

This requirement is necessary in certain markets (e.g. California) so that telecom services can continue to operate in the event of natural disasters.

supports the Commission's proposal to allow operation of all services in the 47 GHz band permitted in the United States Table of Allocations. The flexibility inherent in these policies will let the marketplace determine which technologies and services can most efficiently be provided. From Angel's perspective, this flexible approach should facilitate the implementation of HALO platforms. However, Angel believes that this approach must be tempered by the reality of different systems operating in the same band and in the same or adjacent locations. Specifically, as discussed below, an appropriate mechanism must be established to allow different services and systems to use the 47 MHz band in a coordinated manner.

The Commission requests comments on whether high altitude platform systems ("HAPS") present any special coordination issues.<sup>5/</sup> Specifically the Commission asks if there are any implications for HAPS if different countries adopt different channel schemes. Angel does not believe that if other countries adopt channel schemes for the 47 GHz band different than adopted in the United States that it will adversely impact the use of HALO platforms in the United States. This is because Angel's HALO platform is a dynamic technology that can support a wide range of telecommunication services. Nevertheless, coherent channel schemes should facilitate the resolution of cross-border coordination issues and the implementation of HAPS.

The NPRM also seeks "comment on the possibilities for sharing between government and commercial wireless users in the 47 GHz band."<sup>6/</sup> Angel believes that the Commission should adopt a government/non-government sharing scheme that would facilitate the most efficient use of the

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<sup>5/</sup> See NPRM at ¶ 58.

<sup>6/</sup> *Id.* at ¶ 61.

spectrum resource. To the extent possible, given security and operational requirements, Angel believes that the government should utilize commercial services to meet its communications requirements. However, if the government has dedicated requirements, spectrum should be assigned to the government on a geographic basis as needed. This will insure that spectrum is used in the most efficient manner possible.

As a general matter, Angel supports the Commission's proposed application, licensing and processing rules. These rules are designed to encourage the expeditious introduction of a broad range of services and technologies in 47 GHz band. As discussed above, the adoption of flexible rules and policies will enable the use of HALO platforms in the 47 GHz band. Thus, Angel supports the Commission's proposals relating to regulatory statutes, spectrum aggregation, and foreign ownership restrictions. It also believes that the use of Regional Economic Area Groupings ("REAGS") will further the Commission's goal to create a flexible environment. Angel believes that the Commission's proposed disaggregations and partitioning rules should allow a broad array of 47 GHz band services to be offered by a wide variety of licensees.

**IV. THE TECHNICAL RULES SHOULD BE DESIGNED TO PROMOTE THE IMPLEMENTATION OF A VARIETY OF TECHNOLOGIES AND SERVICES IN THE 47 GHz BAND.**

The Commission in the NPRM proposes a number of technical rules to support its goal of establishing a flexible regulatory structure for the 47 GHz band. As discussed below, Angel supports these proposals with certain minor modifications.

**A. 47 GHz COORDINATION MECHANISM.**

Angel concurs in the Commission's conclusion that high power limits be addressed on a case-by-case basis and that either direct EIRP measurements or indirect calculations be allowed.

This approach is appropriate for the 47 GHz band because it is currently difficult to assess the interference environment in the band given the limited number of existing 47 GHz systems.

Angel disagrees with the Commission's assumed limits of -20 dBW of transmitter power and believes that the limit should be increased to 0 dBW to match equipment specifications currently available. The antenna gain limit of 36 dBi is also low compared to present-day commercial practice. This limit corresponds to an approximate seven inch diameter reflector with a 3 db beamwidth of 2.3 degrees. Today, an 18-inch diameter is practical. Such a reflector would have a gain of approximately 44 dBi (47.5 GHz presumed) and a half power beamwidth of 0.90 degrees. These suggestions would result in a maximum ERP of 44 dBW. The corresponding ground flux density at nadir and from 100,000 ft. (30,480 M) would be -56.5 dBW. The narrow beamwidth would easily allow either a satellite or ground antenna to avoid interference with other systems. The higher ERP proposed will be very helpful to offset the low angle atmospheric losses. Thus, Angel encourages the Commission to increase its proposed 16 dBW EIRP power limit for 47 GHz stations to 44 dBW.

Angel concurs with the Commission's view that spurious emissions and frequency stability requirements be applied to emissions outside a licensee's assigned spectrum. These requirements can promote the successful conclusion of coordination discussions between asymmetrical systems. Furthermore, Angel believes that prior type acceptance of transmitters will also aid in this goal. However, Angel does not believe it necessary to establish temperature requirements or susceptibility standards.

The Commission seeks comment on whether in-band interference should be controlled through the use of a field strength limit at the service area boundary or a general coordination procedure.<sup>2/</sup> Given that there is likely to be a wide variety of technologies and services in the 47 GHz band, it is unlikely a consensus can be reached on the appropriate power flux density or field strength limit. Consequently, a general coordination procedure is appropriate for the band.

It should be noted that for stratospheric platforms there is a clear technological difference between 47 GHz and 2.3 or 4.6 GHz. At 47 GHz, the millimeter wavelengths and the atmospheric attenuation combine to allow the line of sight, relative to the earth surface, to be the line of demarcation. For example, while a beamwidth of less than 1 degree is practical at 47 GHz, such a beamwidth would require an antenna diameter of approximately 9.5 meters at 2.3 GHz. The use of comparatively small apertures and the prohibitive attenuation below 15 degrees could allow an angle to be the discriminating factor. If the terrestrial services were constrained to operate below 10 degrees of earth elevation angle, and stratosphere platforms were constrained to operate above 20 degrees, then a properly designed antenna could provide as much as 50 dB of isolation between the two services. Thus, Angel encourages the use of an elevation angle discriminator as the best method for coordinating stratospheric systems with terrestrial systems. Such an approach would significantly simplify coordination between stratospheric platforms and terrestrial services operating in the same band and in the same territory.

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<sup>2/</sup> The proposed field strength of  $75\mu\text{V/M}$  corresponds to a power level of approximately  $-108\text{ dBm/M}^2$ . If an 18-inch diameter reflector at 50% efficiency is used in consort with a 4 dB noise figure and a requisite S/N of 10 dB, the interference power level at the receiver becomes approximately  $-122\text{ dBm}$ . This figure is quite reasonable for most applications. However, the impact of boundary interference values should be examined for each instant case. There are an insufficient number of 47 GHz systems currently operating to be certain that interference will not be a problem.

Given the above, Angel encourages the Commission to extend the application of Section 101.103 of the Commission's rules, 47 C.F.R. § 101.103 to include the 47 GHz band, but encourages the Commission to adopt an elevation angle discriminator to be used in conjunction with these rules.

**B. OUT-OF-BAND AND SPURIOUS EMISSION LIMITATIONS.**

Angel concurs with the Commission that it is unlikely that there will be adjacent channel interference problems created by 47 GHz licensees, and believes that licensees in the 47 GHz band should be required to attenuate power below the transmitter power (P) by at least  $43 + 10 \log 10(P)$ , or 80 decibels, whichever is less, for any emission on all frequencies outside the licensee's authorized channel.

**C. ANGEL'S HALO SHOULD BE CLASSIFIED AS A HIGH ALTITUDE PLATFORM STATION.**

The HALO being implemented by Angel will operate in a geostationary manner at an altitude ranging from 16.7 km to 18.3 km above the earth. The HALO will be able to maintain the geostationary nature of its footprint by flying in a circular flight path at a central location within the footprint. These characteristics are almost identical to the HAPS considered at WRC-97, except the HALO altitude will be 16.7 to 18.3 kms instead of 20-50 kms. Angel believes it would be inconsistent with the flexible rules and policies proposed by the Commission for the 47 GHz band to exclude HALOs from the definition of HAPS merely because HALOs operate 1.7 - 3.3 km lower

than the HAPS considered at WRC-97. Therefore, Angel urges the Commission to adopt in § 27.4 of the Rules:<sup>8/</sup> the following definition of HAPS.

A station located on an object at an altitude of 15-50 km and at a specified fixed point relative to the Earth.

This definition will enable multiple HAPS technologies including HALOs to flourish in the 47 GHz band. To adopt the proposed HAPS definition would merely result in discouraging use of certain technological approaches based on an arbitrary height limitation. This would be at odds with the philosophical underpinning of the NPRM to promote the use of a wide variety of technologies and services in the 47 GHz band.

**D. THE COMMISSION SHOULD APPROVE CO-CHANNEL SHARING BETWEEN  
STRATOSPHERE AND TERRESTRIAL STATIONS.**

As discussed above, Angel believes that terrestrial and stratospheric systems can share the same spectrum if an angle discriminator is used. Specifically, if a minimum 20 degree elevation angle is used for stratospheric systems and a maximum of 10 degrees is used for terrestrial systems, it is possible to obtain a minimum of 50 dB of isolation between these two technological approaches. Thus, Angel disagrees with the Sky Station position that co-channel frequency sharing of stratospheric platform systems and traditional fixed services is not possible in the same geographic area.

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<sup>8/</sup> Angel urges the Commission to have WRC-2000 amend the existing International Radio Regulations definition of HAPS to conform to and include stations located on an object at an altitude of 15-50 km.

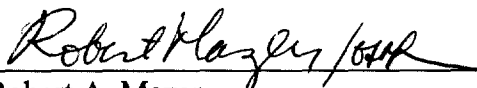
**E. PUBLIC SAFETY ISSUES.**

The NPRM asks for comments on the public safety issues raised by the Sky Station proposal. Angel believes that the Federal Aviation Administration ("FAA") is the appropriate authority to consider the safety issues associated with HAPS. The FAA has the expertise and jurisdiction to determine whether any particular man-made object is flight-ready and does not present safety concern to pilots, passengers, or those on the ground. The Angel team has extensive experience in designing and operating aircraft, and is acutely aware of the safety issues associated with the introduction of a new airplane. Angel will work closely with the FAA to obtain flight certification for the Protous HALO.

**V. CONCLUSION**

As discussed above, Angel urges the Commission to expeditiously adopt rules and policies with the changes suggested herein. These rules will allow the introduction of different services and technologies in the 47 GHz band to the benefit of consignees in the U.S. and around the world.

Respectfully submitted,

  
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Counsel to Angel Technologies Corporation

September 21, 1998



## **APPENDIX A**

### **The Angel HALO Aircraft**

The HALO aircraft configuration is a fixed wing design fabricated with carbon composite materials. Propulsion will be provided by FAA-certified Williams-Rolls Royce twin fan jets. The platform will be operated by a pilot and co-pilot residing in a crew cabin of efficient ergonomic design. The cabin will be pressurized to provide a "shirt sleeve" work environment. Station keeping will be performed by an auto-pilot using coordinates provided by the Global Position Satellite system.

The payload bearing attributes of the HALO aircraft include:

- approximately one ton of weight;
- up to 18 foot diameter payload pod housing the antennas and interfaces suspended below the aircraft;
- 20 to 40 KVA power for the airborne network elements with matched thermal management; and
- bank angle compensation of the pod when required.

Advances in component performance and packaging methods occurring in the consumer electronics and personal computer industries will enable progressive weight reduction of the airborne elements, especially those affecting the digital functions of the HALO Network, without corresponding increases in cost. Consequently, more capability will be packaged per pound and greater performance may be realized per pound over time as the equipment is upgraded.

The HALO aircraft will execute a circular flight path at an altitude ranging from 50,000 to 60,000 feet. From that vantage, wireless services can be offered to users over an area of several

thousand square miles or larger, encompassing a typical major city and its surrounding towns and communities.

Angel will maintain a continual HALO aircraft presence on-station above each market served. Although each HALO will be able to remain airborne in excess of 15 hours, Angel has planned for an eight hour mission time on-station. Three aircraft will be allocated for each isolated site: one on-station, one ascending, descending or being prepared for flight at the local or regional airport facility, and one standby spare. An emphasis on "line replaceable unit" maintenance will allow Angel's dedicated personnel to perform regular and unscheduled maintenance between missions.

Angel will pursue a certificate under FAR23 regulations and will be authorized to operate in the full range of normal instrument flight conditions. Angel's operational plan is very conservative and calls for the HALO aircraft to avoid significant weather by prompt diversion to alternative regional airports with forecast conditions approaching visual flight rules. Even the largest storm systems are only a few hundred miles across, and are thus easily avoided by HALO aircraft.

The following factors contribute to Angel's expectation of achieving high operating reliability with HALO aircraft:

- Many decades of experience with airborne military transport and express freight aircraft large fleet operations will be applied.
- Angel will utilize fleet redundancy to ensure continuity of service in anticipation of worst case operational failure scenarios. Angel will position flight ready standby HALO aircraft on the ground and, when required, in the air.

- HALO aircraft fleet operations will be steadily improved as the aircraft design is refined and as operating behaviors and performance are logged, analyzed, and utilized to upgrade choices of components and maintenance activities.
- The simple, robust design of HALO aircraft exceeds the reliability of typical fan jet aircraft. Angel's HALO aircraft design will benefit from the aerospace industry's decades of reliability engineering to achieve unparalleled levels of mission reliability.
- HALO aircraft incorporate redundant mission critical systems. The HALO aircraft's systems are being selected for high reliability.

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1 Pamphlet